An aerial photograph of a mountainous landscape with dense green forests. In the foreground, a 3D model of a town is overlaid, showing numerous brown rectangular blocks representing buildings. The town is situated in a valley, with roads and fields visible. The background shows steep, forested hills under a clear blue sky.

Enhancing the Fire Dynamics Simulator (WFDS) for Modeling WUI Fires

Derek McNamara

GIS Analyst

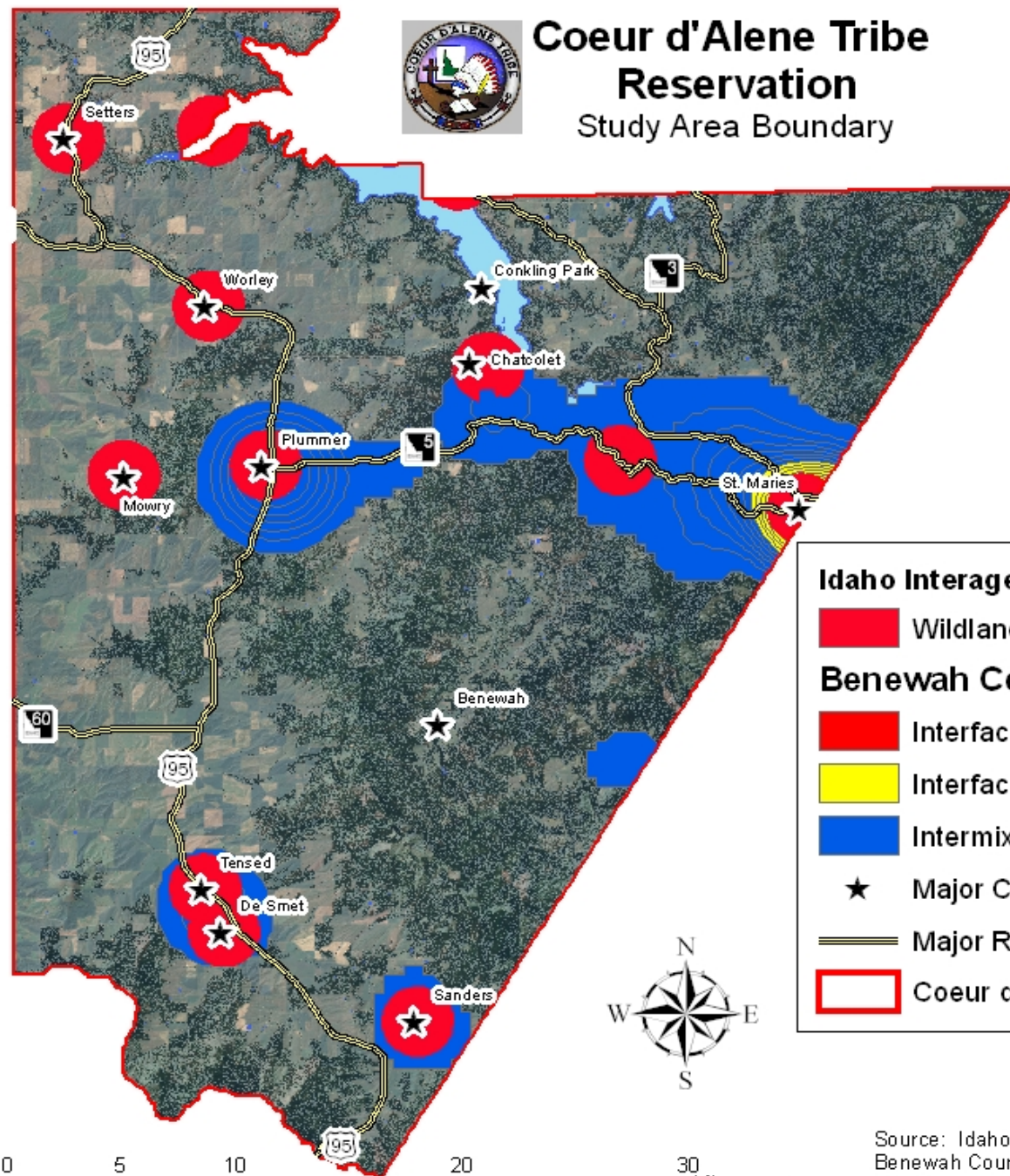
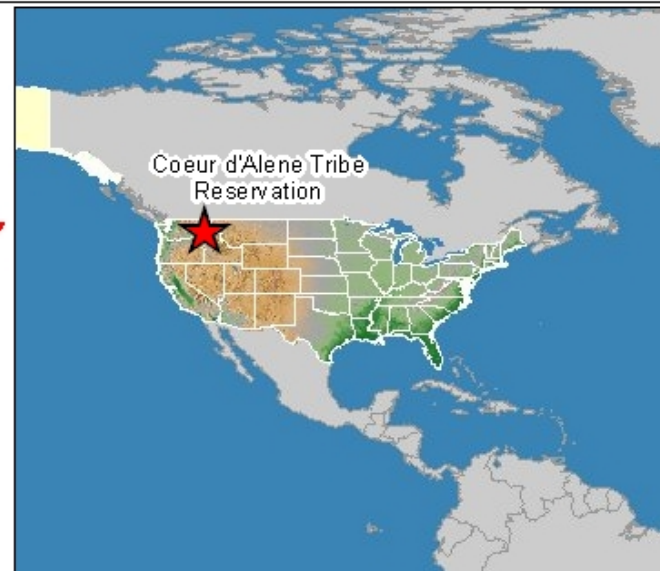
Coeur d'Alene Tribe

Project Goals

- Provide WFDS Group Spatial Data
 - Remotely Sensed
 - Detailed Ground Surveys
- Identify Minimum WFDS inputs for WUI
 - Parsimonious Dataset
 - Mapping Protocols
- GIS Database and Application Linkage
- Testing Model Outputs
- Model Validation & Calibration



Coeur d'Alene Tribe Reservation Study Area Boundary



Idaho Interagency Assessment of Wildland Fire Risks

Wildland Urban Interface

Benewah County Wildland Urban Interface

Interface: High Density

Interface: Medium Density

Intermix: Low Density

★ Major Cities

== Major Roads

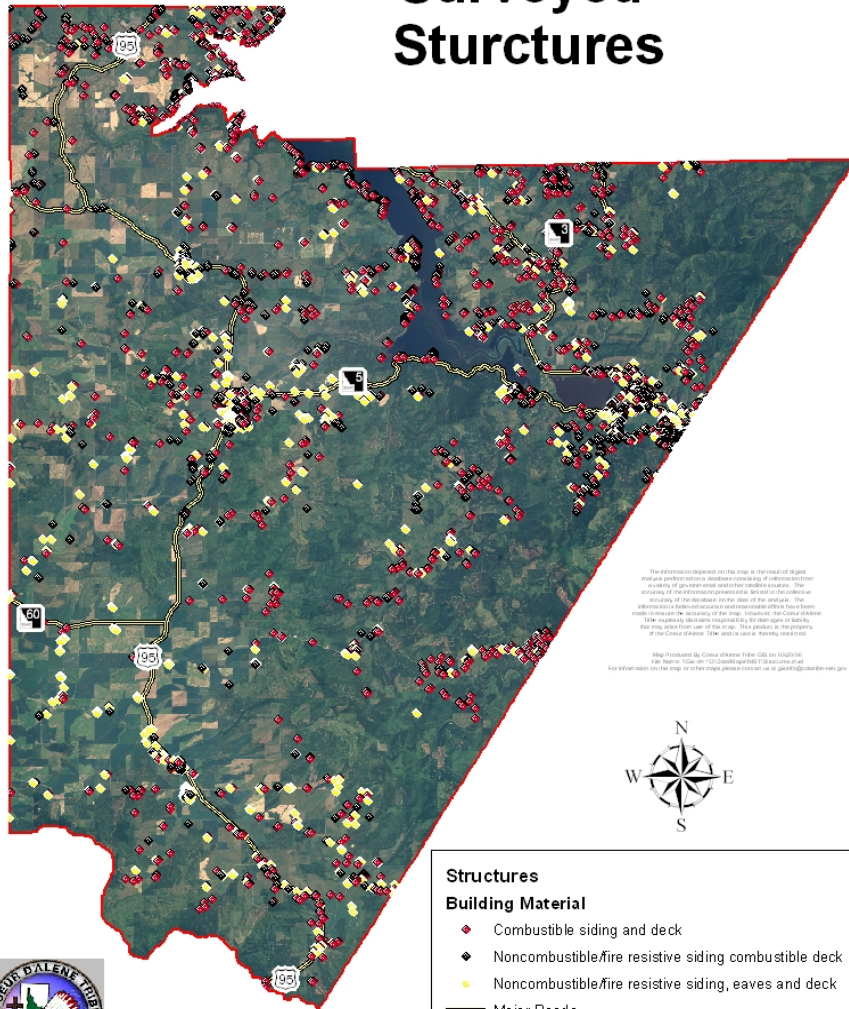
Coeur d'Alene Tribe Reservation



0 5 10 20 30 Kilometers

Source: Idaho Interagency Assessment of Wildland Fire Risks;
Benewah County, Idaho, Wildland-Urban Interface
Wildfire Mitigation Plan.

Surveyed Structures



The information displayed on this map is the result of a global analysis performed using a database containing information from a variety of government and other credible sources. The accuracy of the information presented is limited to the collected sources of the database and the date of the analysis. The information is believed to be accurate, but it may have been made to ensure the accuracy of the map. However, the Center of Disease Control is not responsible for any errors or omissions. The map is not intended to be used for any purpose other than the purpose of the Center of Disease Control. The analysis was performed on 10/10/06.



Structures

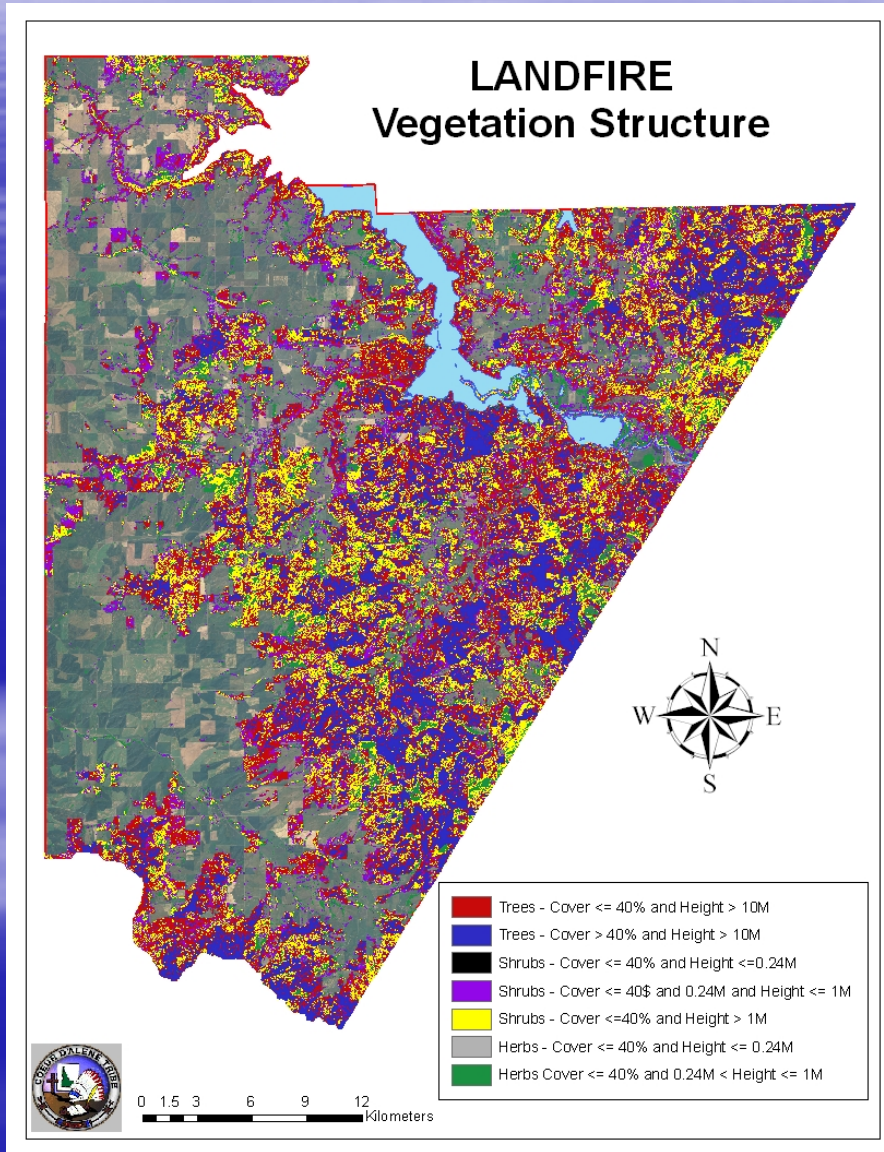
Building Material

- ◆ Combustible siding and deck
- ◆ Noncombustible fire resistive siding combustible deck
- Noncombustible fire resistive siding, eaves and deck
- ▬ Major Roads
- ▭ Couer d'Alene Tribe Reservation



- 5907 Surveyed
- NFPA Form 1144
 - Building Type
 - Commercial Status
 - Building Material
 - Roofing Class
 - Fuels Present
 - Emergency Response
 - Risk Ratings
 - Location
 - Photos

Fuels Monitoring & Mapping (FIREMON & LANDFIRE)



- Vegetation, fuels, Tree Data
 - Vegetation Datasets
 - Vegetation Fuel-Classess
 - Ground-Truth
- LANDFIRE
 - Regression Tree
 - 30 meter & 1 meter

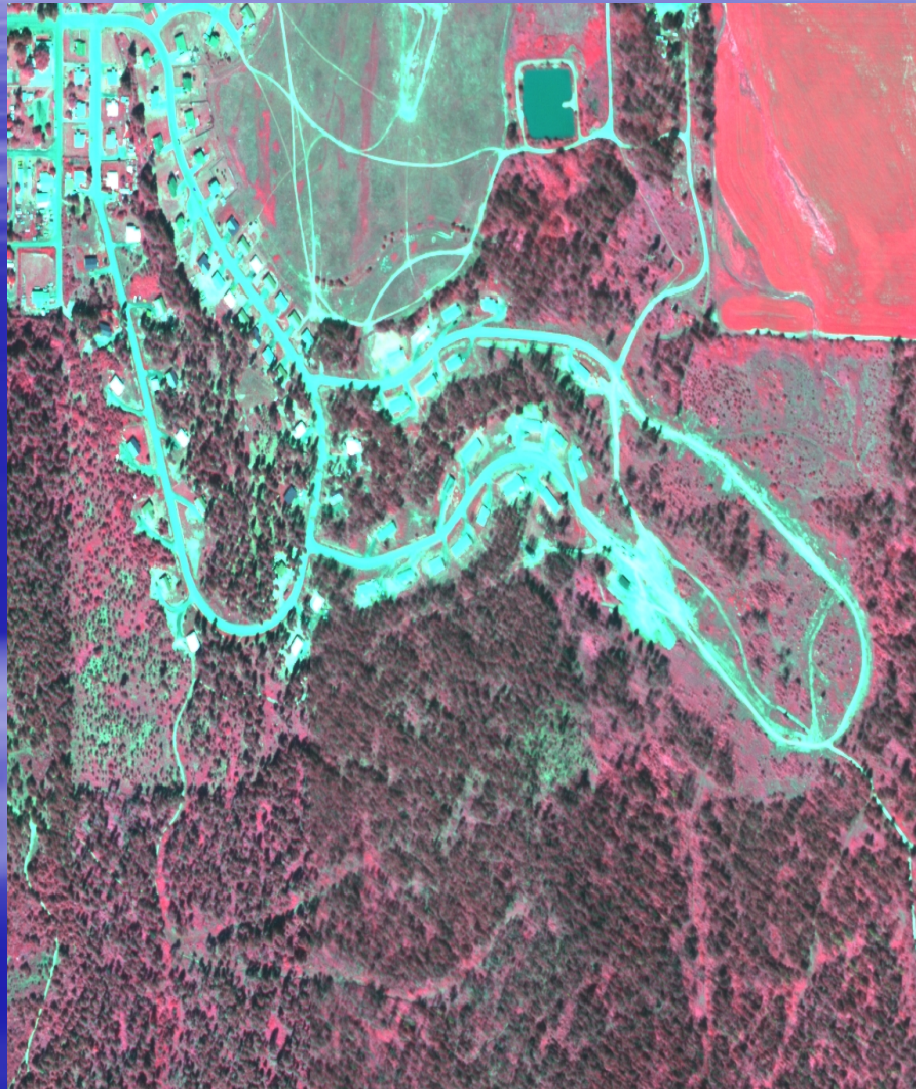
Satellite & Aerial Imagery

Color-Infrared

Landsat 7 ETM+

True Color

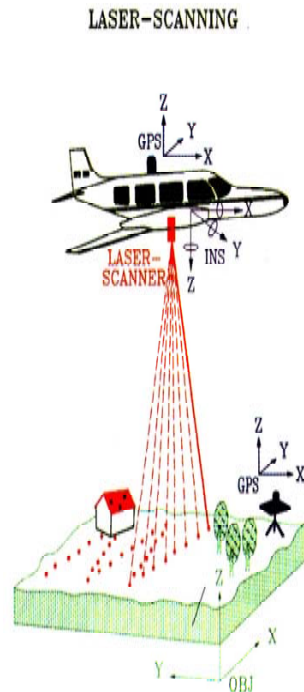
National Agriculture Imagery Program (NAIP 2004) 30 Meter National Agriculture Imagery Program (NAIP 2004)



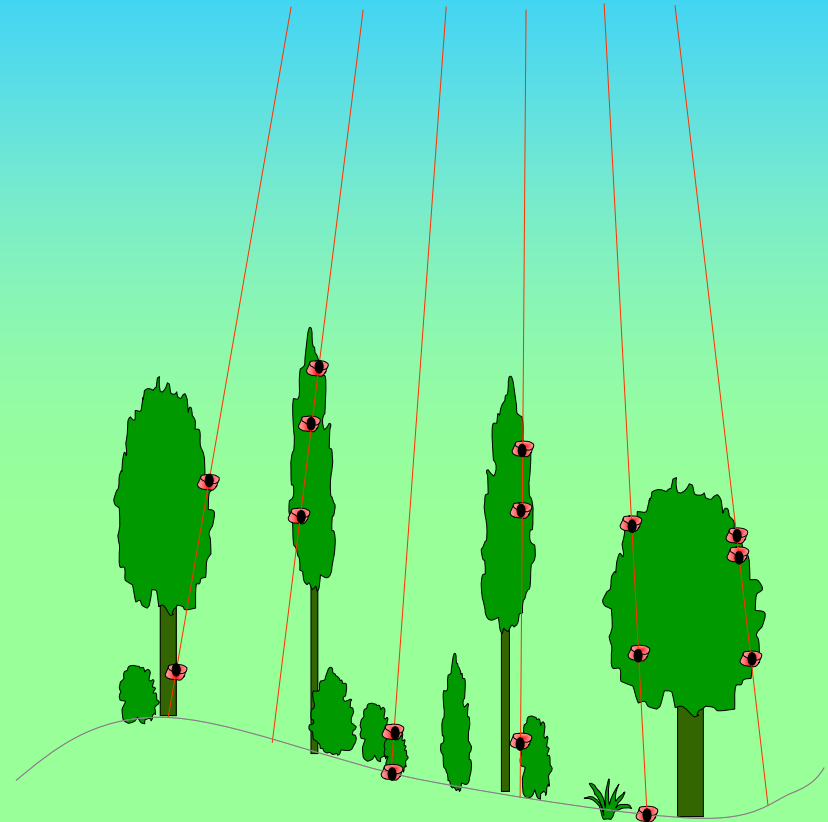
Light Detection and Ranging (LiDAR)

- What is LiDAR?
 - Remotely Sensed Elevation

- Why LiDAR?
 - High Accuracy
 - 15cm Vertical
 - <10cm Horizontal
 - Cost Effective
 - Many Applications

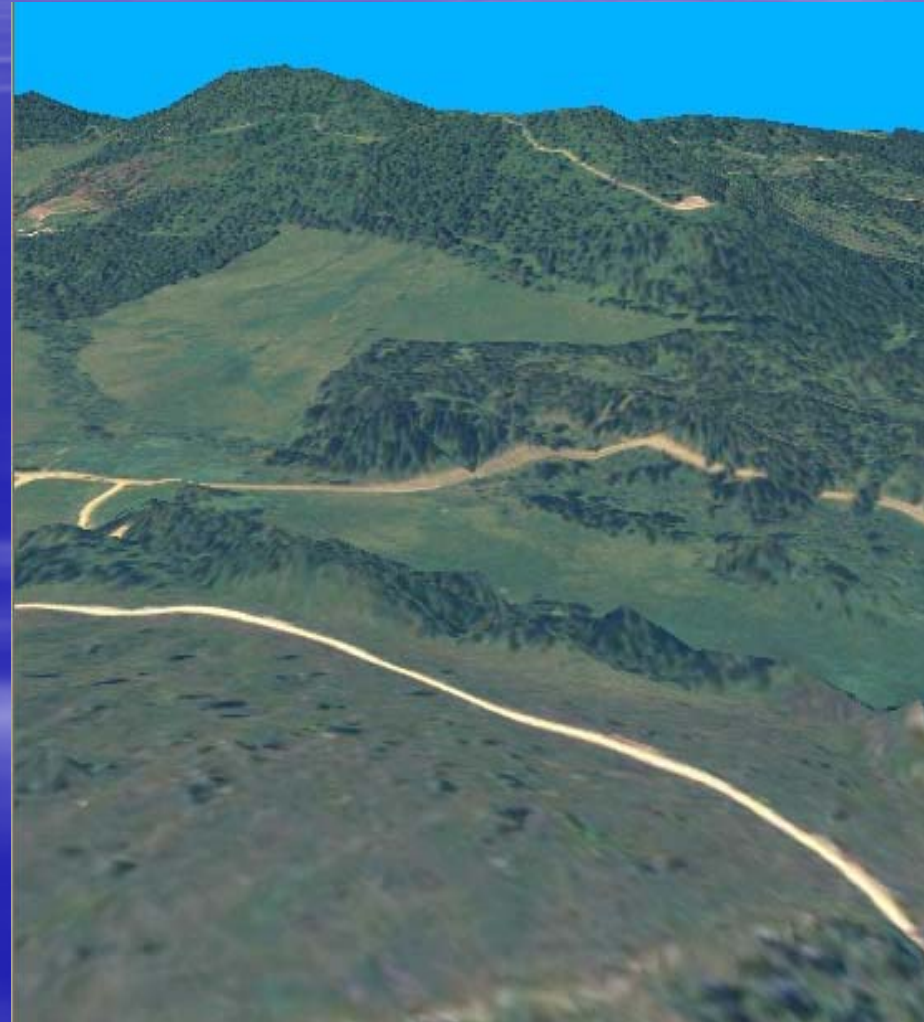


Multiple Return



LiDAR Products

- Digital Elevation Models
- Building Footprints
 - Heights, Roof Type, Slope
- Tree Stem Locations
 - Heights, crown radius, DBH
- Fire Barrier Locations
 - Roads
 - Parking Lots
 - Dirt Patches
- Power Lines (?)



Ancillary Data

(Corporate GIS Database)

- Roads
- Power Line Poles
- Streams
- Railroads
- Communication Towers
- Etc...

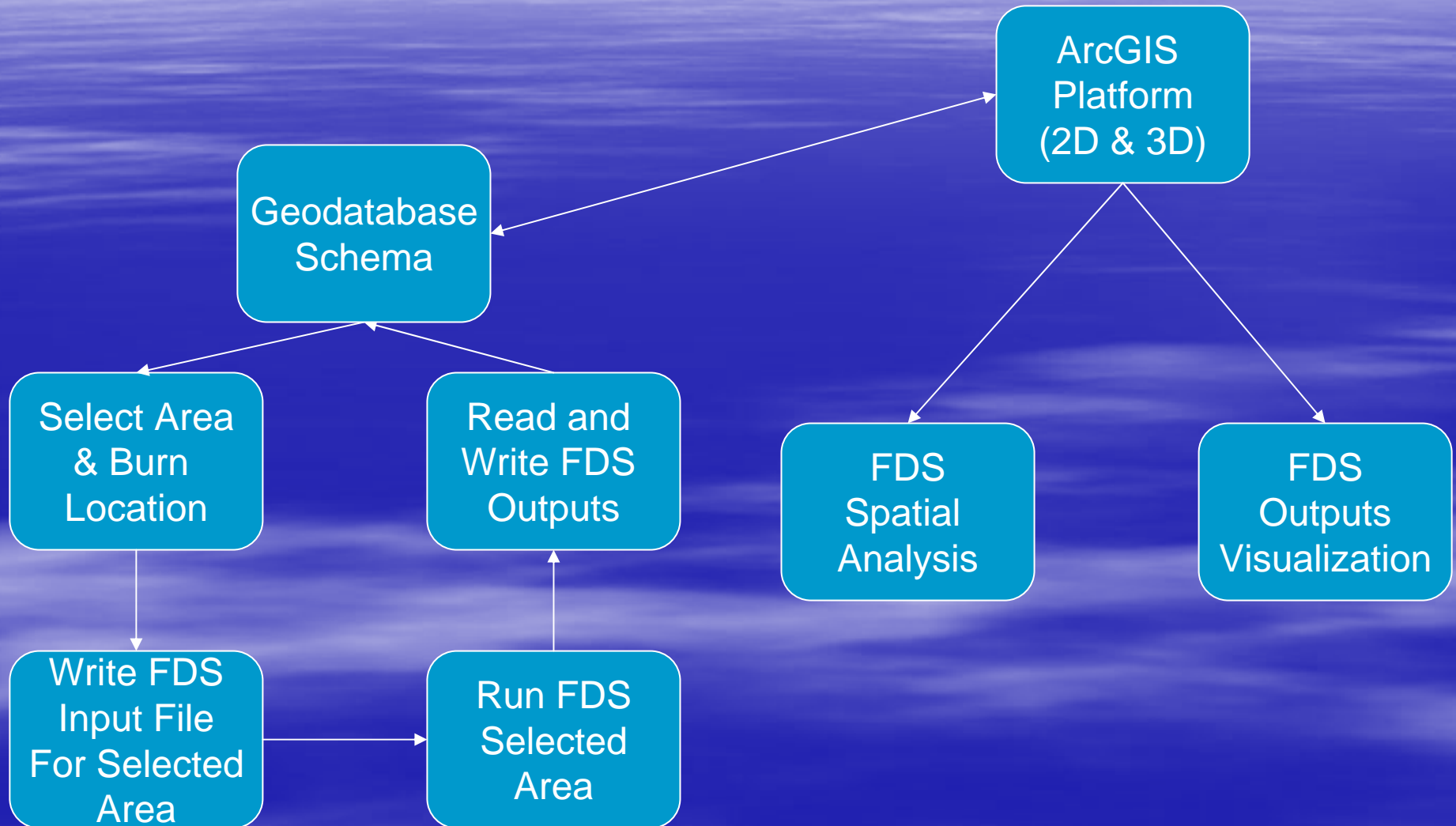


New Surveys

- Ground-Truth:
 - Tree Stems and Derivatives
 - Building Footprints
 - Vegetation
- More Detailed Databases
 - Vent Locations
 - Smaller Structures
 - Other Burnable Materials



GIS Linkage (Loose Coupling)



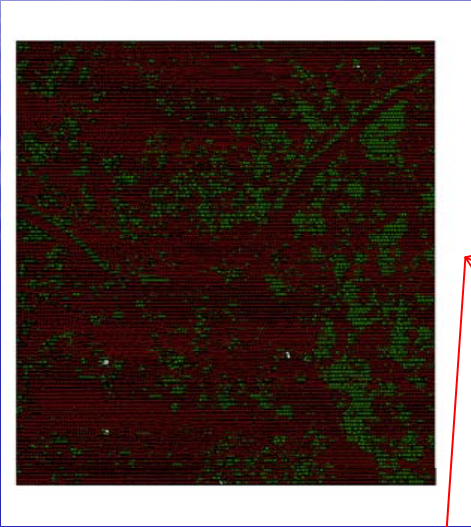
Model Validation & Testing

- Unique Challenges
 - Fire Enter Tree Canopies
 - Burn Structures
 - Environmental Issues
- Test Difference
WFDS Outputs
 - Determine Data Requirements

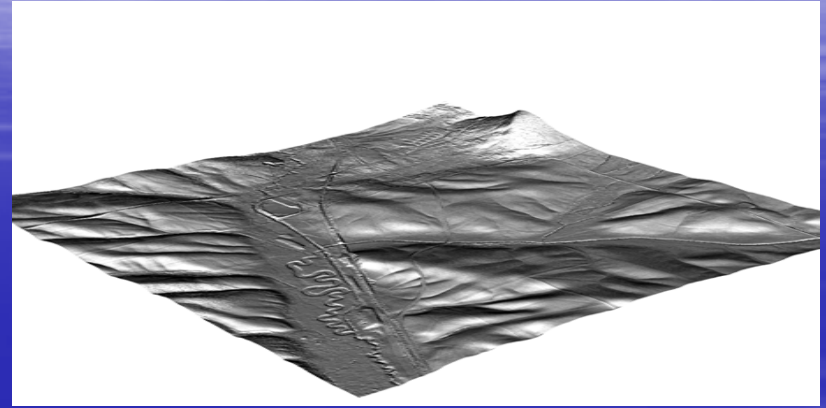


LiDAR Initial Processing

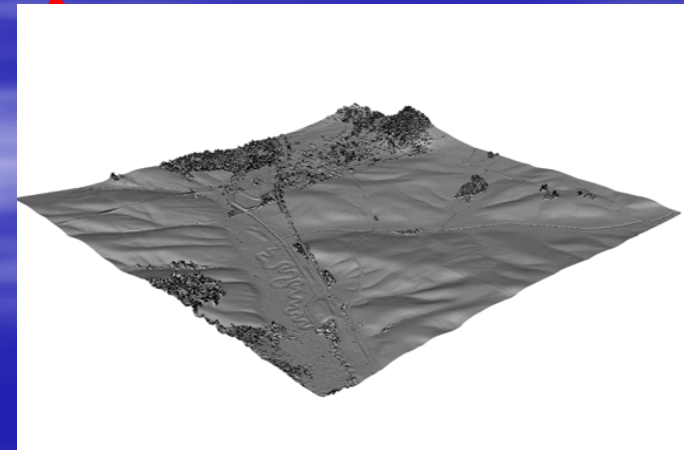
Point Cloud Filtering



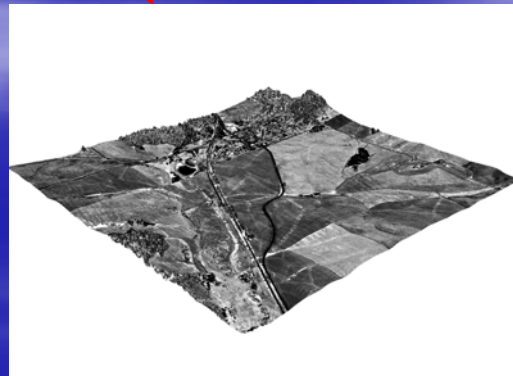
1). Bare Earth Digital Elevation Model



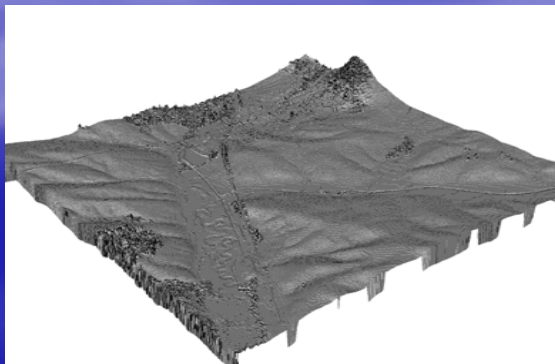
2). First Return Digital Surface Model



3). Intensity



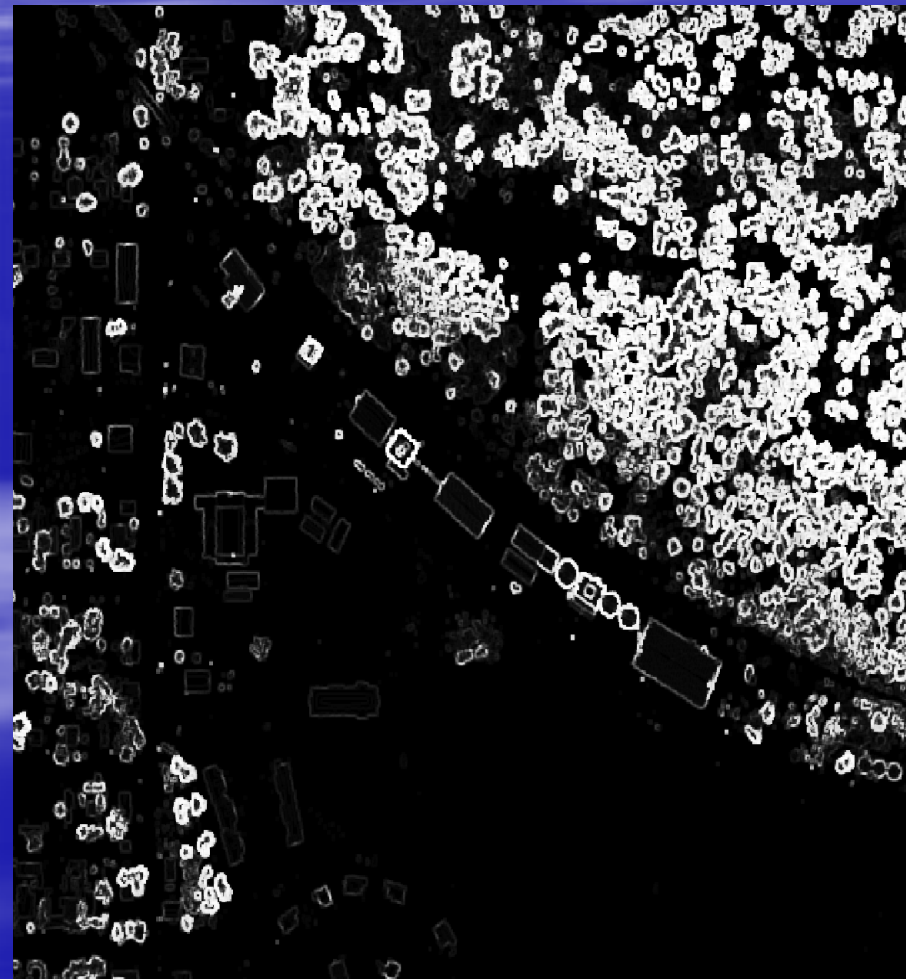
4). Last Return Digital Surface Model



Building Footprints

LiDAR Texture
Morphological Filters
(Shape Outlines)

Multispectral Reflectance
Principal Components Analysis
(Differentiation of Features)

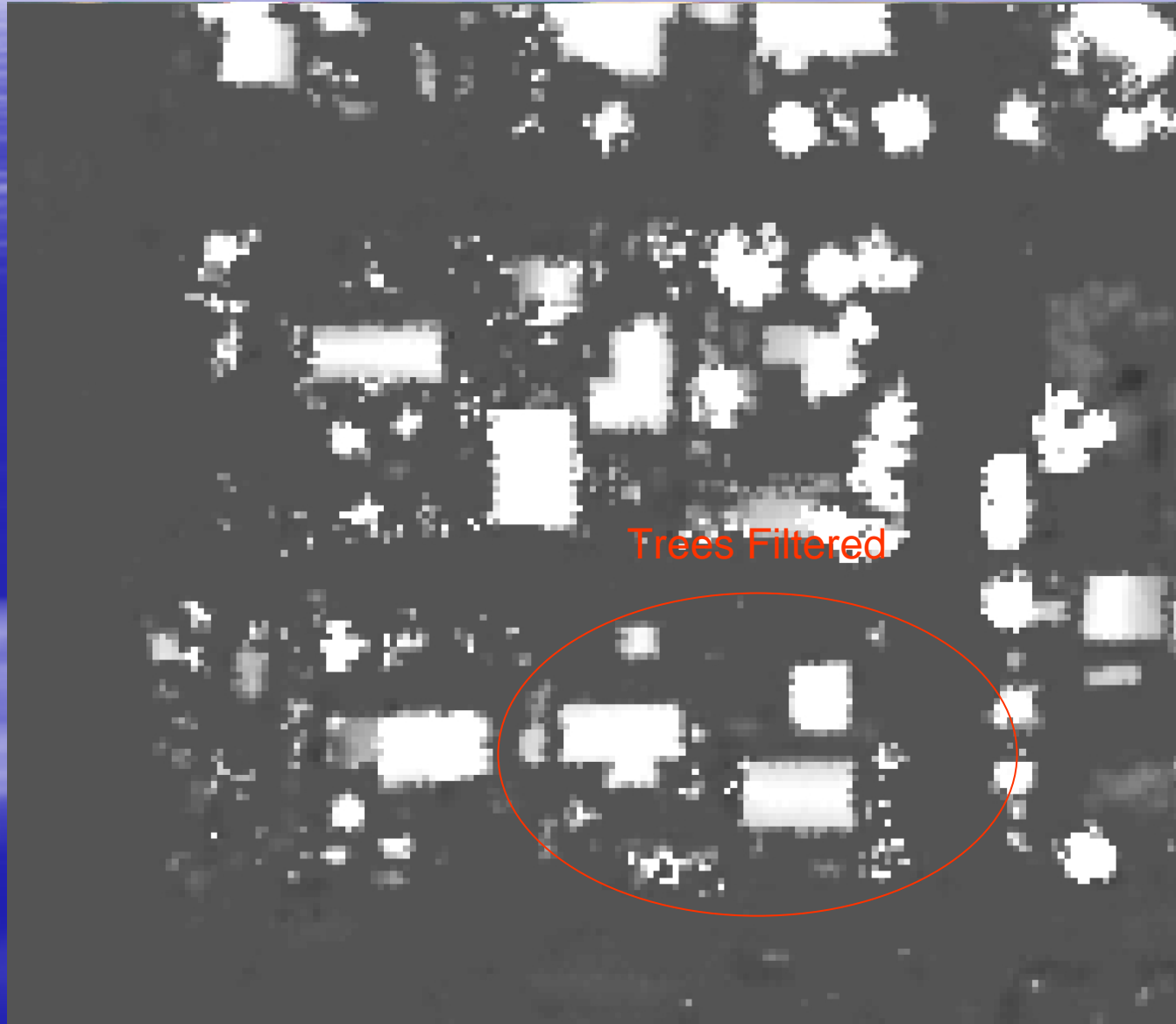


Building Footprints



- Binary Classifications
- Combine Images
- Supervised Classifications
- Square-up Features
- Manual Clean-up

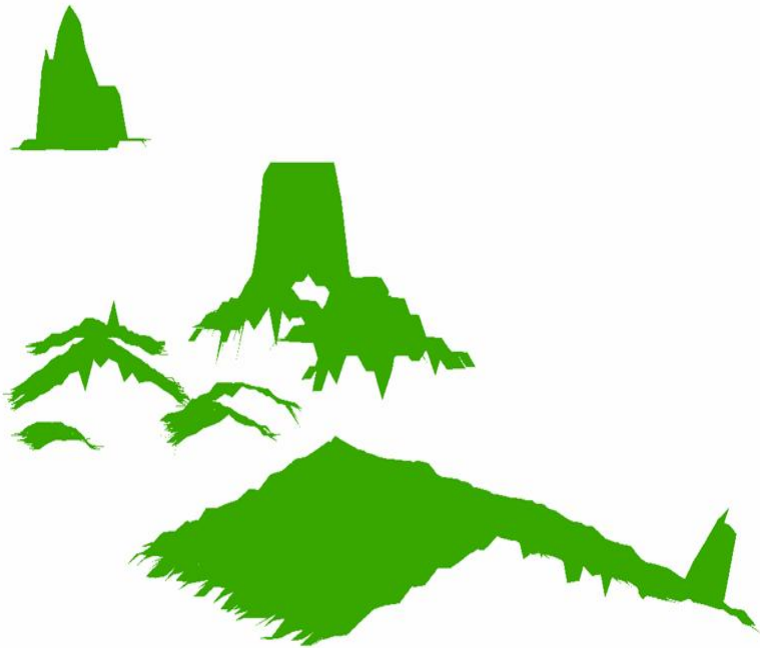
Building Footprints (Buildings Surrounded by Trees)



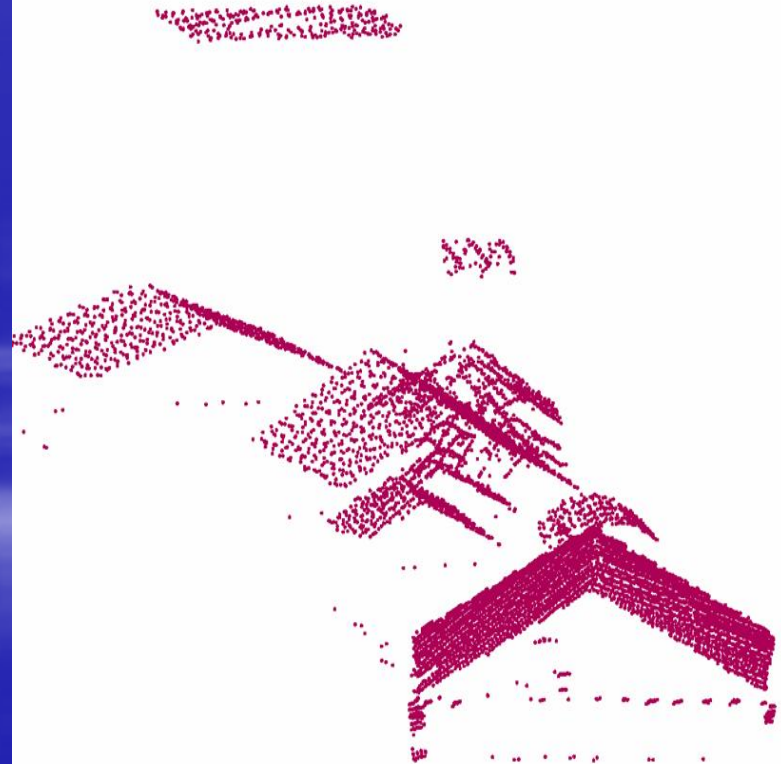
First Return

Building Heights or Roof Types (What do we need?)

Building Heights
(First Return – Bare Earth)

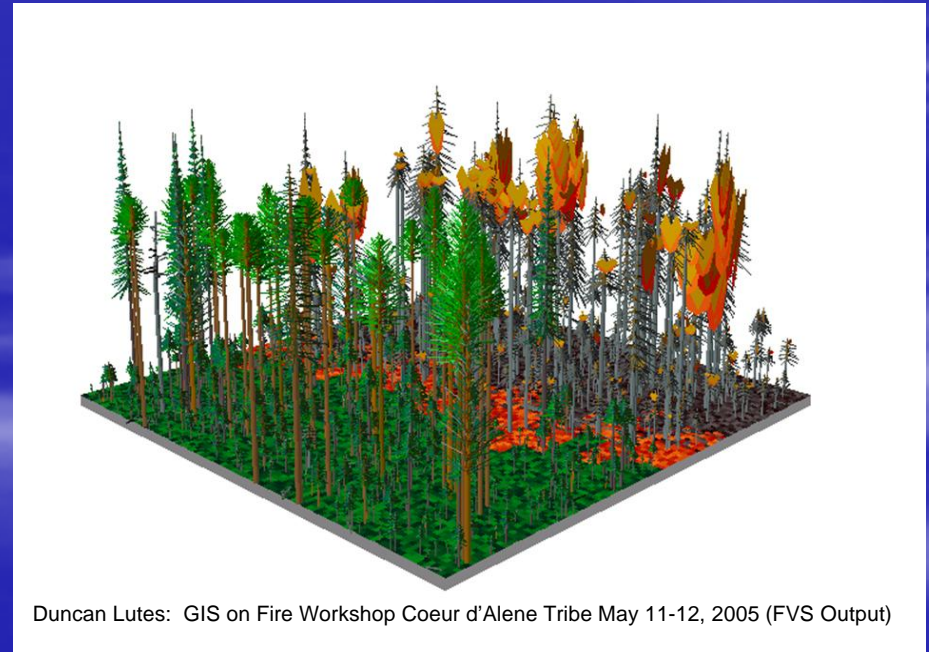


Roof Types
(Plane Fitting Algorithms)



Tree Stem Locations and Derivatives

- University of Montana (Fire Lab)
 - Tree Stem Locations
 - Tree Height
 - Crown Width
 - DBH (?)
- TreeVaw
- Early Stages

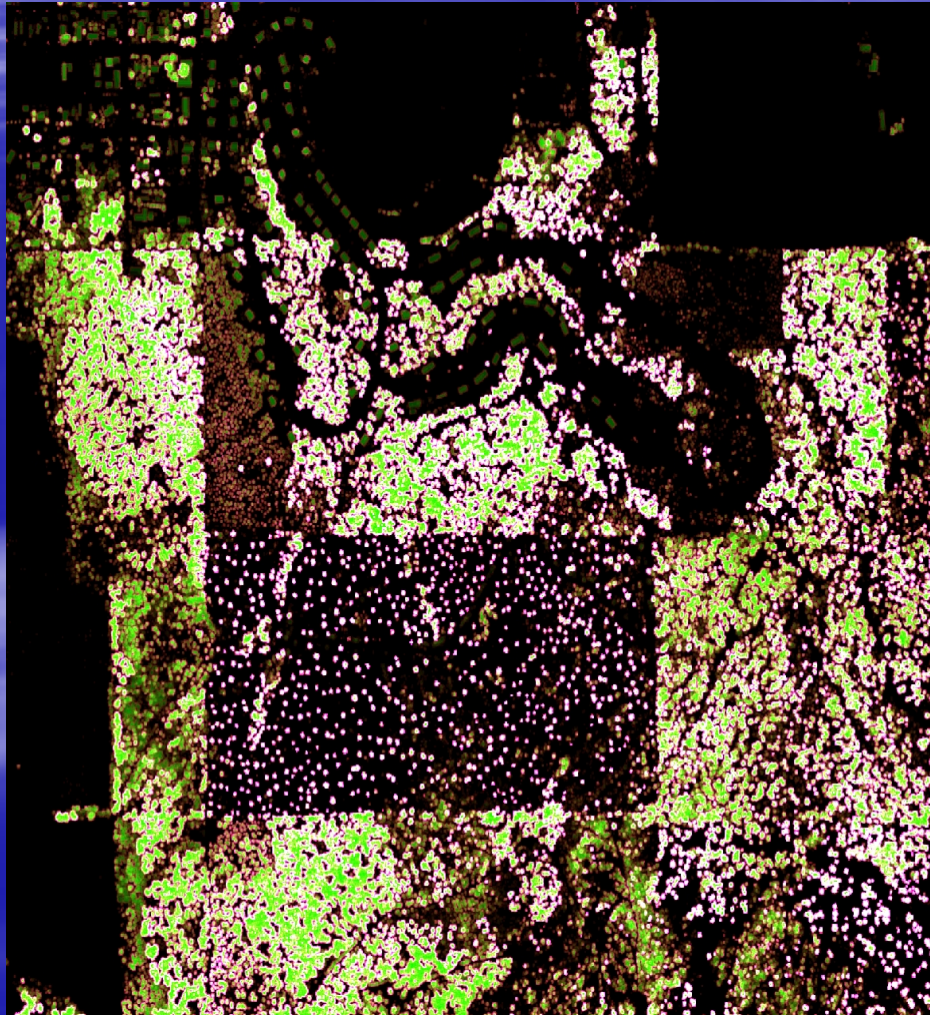


Vegetation Classifications

LiDAR Spatial Statistics
(Morphological Filters)

+

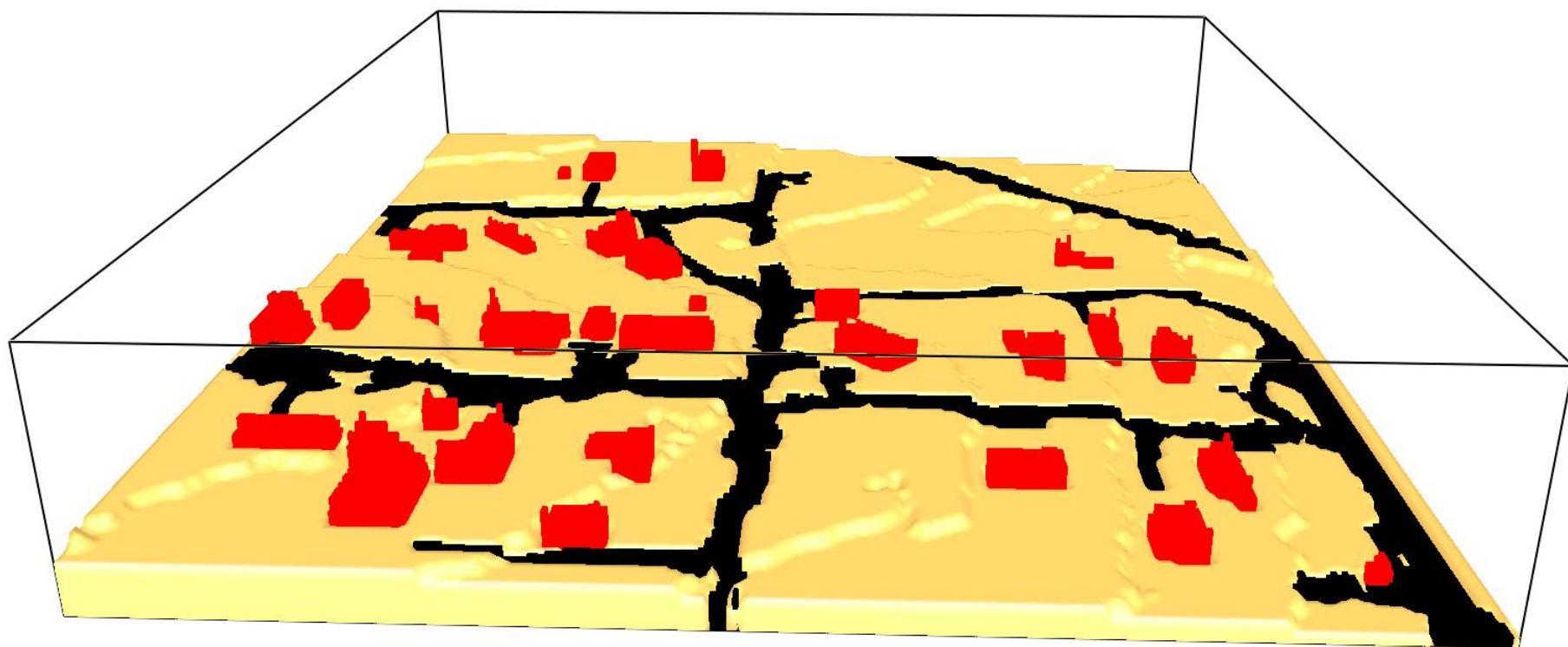
NAIP Multispectral
Data



Roads (Fire Barriers)



- Multispectral data
- Image Classification
- Less Manual Clean-up



Where do we go from here?

- Finish with LiDAR and Multispectral Derivatives
- Learn WFDS (Dataset Identification)!!!
- Develop GIS Applications
- Collect Detailed Survey Data
- Test WFDS Outputs (Model Validation)

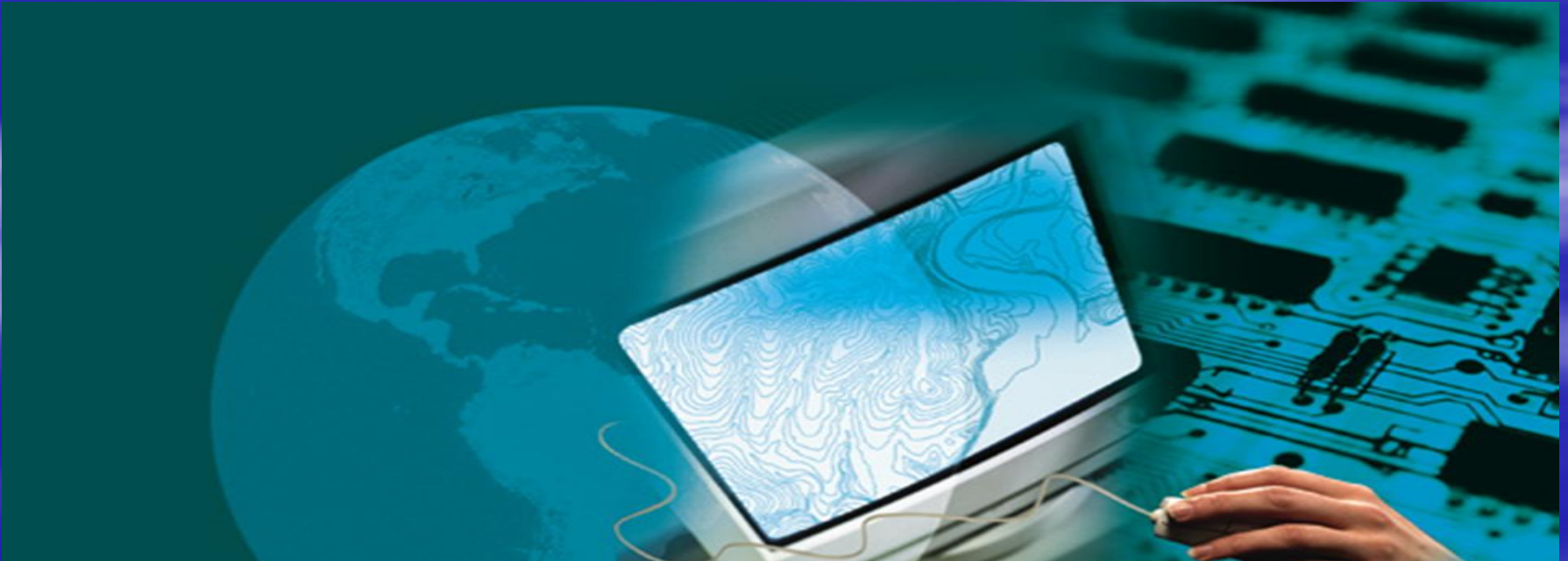
Acknowledgements

- Eric Rowell (Fire Lab)!!!!!!
- Frank Roberts (CDA Tribe GIS Manager)
- James Twoteeth (CDA Tribe GIS Analyst)
- Berne Jackson (CDA Tribe Senior Analyst)
- NIST

Questions?

What is GIS?

- Spatial Data
 - Storage & Analysis
 - Capture & Manipulation
 - Graphic Display
- Computer-assisted mapping & Statistical Analysis



Project Justification

- Population growth rates.
 - 1.9% increase in Idaho (2003-2004)
- No management tool for WUI.
- Geographic Information System (GIS) Linkage.
- Direction for further research.